Researchers use sound waves to levitate objects in three dimensions

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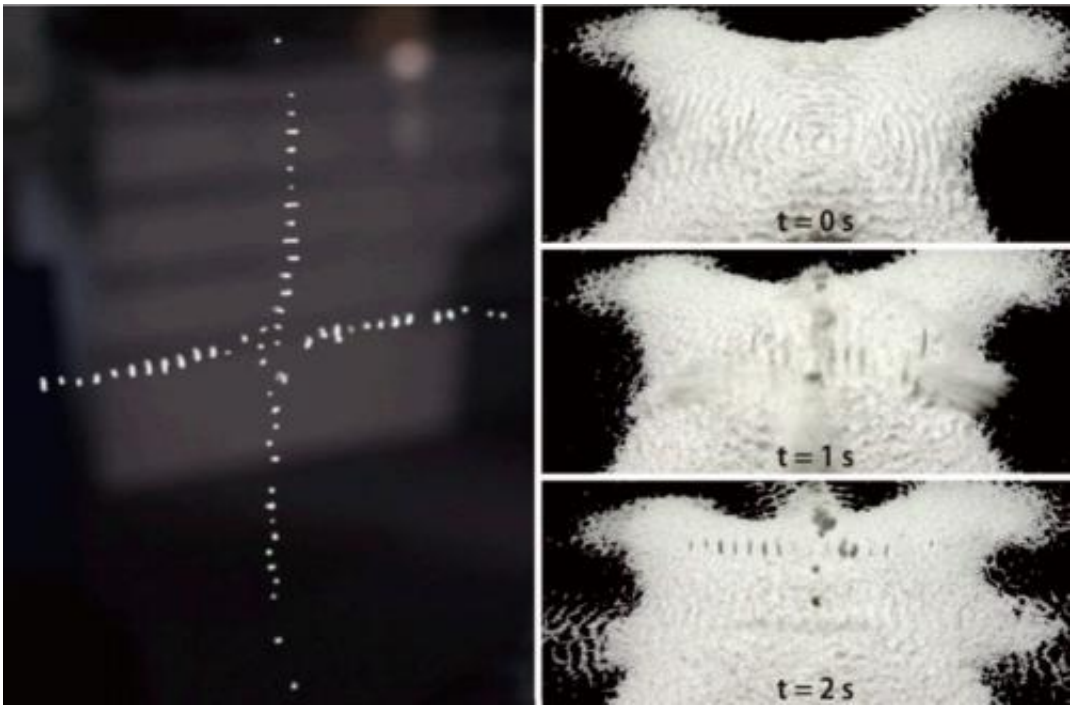

(left) Levitation and manipulation of particles. (right) Scooping up and holding particles. Credit: arXiv:1312.4006 [physics.class-ph]

(Phys.org) —A trio of researchers with the University of Tokyo in Japan has expanded the science of sound wave levitation by adding more speakers and controlling the focal point of the waves that are created. In so doing, as they describe in their paper they've uploaded to the preprint server *arXiv*, they have created a means for levitating and moving objects in three dimensional space.

Scientists have come up with several ways to levitate objects—using compressed air, or magnetics, are just two examples—most such efforts have left a lot to be desired, however, when the goal has been clean (no noise, simple ways to move an object, etc.) levitation. That has led researches to investigate using ultrasonic waves. Up till now, researchers have been able to use the energy of sound waves to push an object from a surface up into the air, and then to hold it there. Because the object isn't moved in any other direction, this type of levitation is considered two dimensional. In this new effort, the research team has taken the idea further by adding more speakers and a control mechanism that allows for moving the focal point of the sound waves generated. Objects are captured in the focal point and are then moved around by causing the focal point to be moved.

In their experiments, the researchers first levitated and moved around very tiny Styrofoam balls. They demonstrated an ability to move the balls at will in virtually any direction—in tandem. Subsequent tests revealed that their apparatus was capable of levitating and moving tiny electric parts, a piece of wood and a metal nut. The nut was perhaps most impressive as it represented a much heavier object. The researchers explain that two of the speakers are used for levitation, while two more are used to move the focal point.

The levitating device the team created is also very clean—it produces no noise that the human ear can hear and manipulating objects in three dimensional space is as easy as moving a joystick. It doesn't of course herald in the age of hover-boards as seen in "Back to the Future," but it definitely opens the door to new possibilities, limited only perhaps, by the amount of energy an application is willing to exert in order to levitate ever heavier objects.

More information: Three-dimensional Mid-air Acoustic Manipulation by Ultrasonic Phased Arrays, arXiv:1312.4006 [physics.class-ph]

arxiv.org/abs/1312.4006

Abstract

The essence of levitation technology is the countervailing of gravity. It is known that an ultrasound standing wave is capable of suspending small particles at its sound pressure nodes. The acoustic axis of the ultrasound beam in conventional studies was parallel to the gravitational force, and the levitated objects were manipulated along the fixed axis (i.e. one-dimensionally) by controlling the phases or frequencies of bolted Langevin-type transducers. In the present study, we considered extended acoustic manipulation whereby millimetre-sized particles were levitated and moved three-dimensionally by localised ultrasonic standing waves, which were generated by ultrasonic phased arrays. Our manipulation system has two original features. One is the direction of the ultrasound beam, which is arbitrary because the force acting toward its centre is also utilised. The other is the manipulation principle by which a localised standing wave is generated at an arbitrary position and moved three-dimensionally by opposed and ultrasonic phased arrays. We experimentally confirmed that expanded-polystyrene particles of 0.6 mm and 2 mm in diameter could be manipulated by our proposed method.